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Unit on Volume and Surface Area

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Topic: Computation of Volumes & Surface Areas of Rectangular Prisms using Excel

Aim / Goals & Objectives:
 (Cognitive skills / Affective /
 concepts / new terms /
 applications)

To... solidify computation of volume and surface area of rectangular prisms and cylinders using a technology tool, and comparing volumes and surface areas between objects.

Students will be able to...

- setup an Excel spreadsheet for the calculation of volume and surface area of any two rectangular prisms and any two cylinders,
- check their setup to assure accuracy of their model,
- compare volume between rectangular prisms of different dimensions,
- compare surface area between rectangular prisms of similar volume,
- generalize minimizing surface area of a rectangular prism,
- compare volume between cylinders of different dimensions,
- compare surface area between cylinders of similar volume,
- compare volume between rectangular prisms and cylinders of similar dimensions,

NYS Math Standards & Performance Indicators:

Key Idea 1: Reasoning

- 1a. Apply a variety of reasoning strategies.
- 1b. Make and evaluate conjectures and arguments...
- 1c. Make conclusions based upon inductive reasoning.

Key Idea 4: Modeling / Multiple Representation

- 4a. Visualize and represent 3 dimensional shapes
- 4e. Use variables to represent relationships
- 4f. Use to describe the operation of ...processes and systems.
- 4g. Develop and explore models...
- 4i. Use ...tools to construct and verify geometric relationships.

Key Idea 5: Measurement

- 5c.apply formulas....
- 5e. Explore and produce graphic representations of data

Key Idea 7: Patterns/Functions

- 7a. ...describe and generalize a wide variety of patterns and functions
- 7b. ...represent patterns and functional relationships using....
- 7d. Develop an understanding of functions and functional relationships: that a change in one quantity results in the change in another
- 7e. Verify results of substituting variables.

Interdisciplinary Connections:

Prerequisite Competencies:

- Rectangle & circle, and areas and circumference of both
- Concept of rectangular prism and cylinder and their dimensions
- Basic computation of volume and surface area of rectangular prisms and cylinders.
- Some experience with PC and Excel

Special Resources:

PC with overhead display in computer lab. PC for each student w/Excel software. Hand calculator for each student. Separate overhead projector for transparencies or chalk/white board w/markers.

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Agenda:

- Do-Now
- Introduction
- Instruction
- Practice
- Summary & Challenge
- Assign Homework
- Ticket-out-the-door
- Dismissal

Do-Now warm-up:

Have on board:

- diagram of rectangular prism and associated volume and surface area formulas
 - diagram of cylinder and associated volume and surface area formulas
- 2 examples of each to calculate to ensure they are familiar with the computation .
Assure the class has proficiency in these calculations.

Essential Question:

Motivation /

Review /

Anticipatory Set:

Excel: overview to class

- Want to create spreadsheet to calculate volume and surface area of two rectangular prisms and two cylinders
- Want to do it by building in the formulas so the spreadsheet easily does the calculation for any dimension
- Want to do it so it calculates a table of volume and surface areas for a range in widths and diameters
- Want to do it so we can check to make sure the model we've done is accurate
- Want to learn a bit more about how to work Excel

Want to be able to look at and compare volumes and surface areas of different rectangular prisms and cylinders.

Tie this to these questions:

- what happens when the length of a side is doubled?
- If you have 24 little cubes to make a box for, does it take more/less cardboard to bake a box one way instead of another – 1x24? 2x12? 3x8? 4x6?
- Does a cylinder of dimensions similar to a cube fit inside the cube or does the cube fit inside the cylinder?

Lesson Details:

(Procedures /
Instructional Formats /
Approaches / Methods /
Modeling / Activities /
Anticipated Difficulties
/ Connections...)

Steps:

- File/New/Workbook
- Save-as if possible on the PC/Network
- Start by labeling a bit for a rectangular prism in Column A:
 - 1st row: Object
 - 2nd row Length
 - 3rd row Height
 - 4th row Width
 - 5th and below 1, 2, 3, 4, 5, 6...22, and 0 (should be in row 27) to represent various widths
- Now label a bit for a cylinder in column B:
 - 4th row Diameter
 - 5th row press = and click A5 and enter to have it be the same value as

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- the first column's width (discuss the trivial formula)
- Edit/Fill down through row 27 so that the diameters should appear the same as the widths.
 - We know we are going to need to use the radius for calculations, so
 - label B4 Radius
 - B5 press = and click B5, press /2 to divide by 2 and enter to see 0.5
 - See the formula and discuss
 - Fill down through B27 to see all the radius are one-half the diameter
 - Make the numbers look consistent by selecting the whole spreadsheet (empty box to the left of column A above row 1) and do Format/Cells/Number Tab/Number/Decimal Places 2 and OK so all the numbers show up with one decimal place.
 - Prepare to do our first calculation of the volume of a rectangular prism by:
 - Select column B and Insert/Column pushing the diameter/radius columns right
 - Label B1 Rectangular Prism 1
 - Label B4 Volume
 - Select the whole spreadsheet again and Format/Column/Autofit and press the column centering icon so the words stay within the column and look centered.
 - We will be entering length and height numbers in B2 and B3 to calculate volumes so let's name them rp1len and rp1ht.
 - Select B2 and click on the B2 showing above it
 - Type rp1len and hit enter
 - Select B3 and click on the B3; type rp1ht and hit enter
 - Now enter 2 into B2 and 3 into B3 so we can initially use these values
 - Enter in the first volume formula by:
 - Select B5 just below volume
 - Review the volume as lwh with implied multiplication between. Point out that excel needs to be told of multiplication
 - Enter =, click the rp1len cell, *, click A5 for the width, click the rp1ht cell and press enter to see the correct volume of 6.0. Look at the formula to see =rp1len*A5*rp1ht and discuss the substitution taking place.
 - Fill down to B27 to see all the various volumes with a fixed length and height and a varying width. Check several of them. Notice what happened in the row that has a width of 0. Temporarily double one dimension and discuss the results.
 - Create a surface area column and calculations by:
 - Select column C and Insert/Column to use for surface area
 - Label C4 Surface Area
 - Review the formula for surface area as $2lw+2lh+2wh$ with implied multiplication and order of operations. Point out that excel knows about order of operations.
 - Select B4 and enter =2*rp1len*A5+2*rp1len*rp1ht+2*a5*rp1ht to see a surface area of 22. Discuss the substitution and check it.

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- Fill down through C27 and spot check them.
- Temporarily double the length and discuss the implications.
- As a possible extension, specifically discuss if the width is 0.
- Create the same thing for rectangular prism 2
 - Insert another column before column D
 - Label it Rectangular Prism 2
 - Name D2 rp2len and put in the value 3
 - Name D3 rp2ht and put in the value 2
 - Label D4 Volume
 - Enter the formula and fill down to see the same volumes as RP1. Notice $2*3$ is equal to $3*2$.
 - Insert another column before column E
 - Label D4 Surface Area
 - Enter the formula and fill down to see the same surface areas as RP1. Notice the order of sides does not matter.
 - Snug up things by selecting the whole spreadsheet and Format/Column/Autofit
- Have students try len/ht values of $4/6$ and $3/8$ and compare volumes and SA. Discuss same volume and explore why SA of $3/8$ is larger than $4/6$.
- Try $4/6$ and $5/4.8$ and discuss further.
- Have students enter 4.898979486 and same for rp1. Discuss what is stored and used vs. what is displayed by going back and clicking on it. Discuss if you see a pattern of minimum surface area if base of RP is square vs. rectangular. Speculate cube vs. rectangular prism.
- Go back/on to cylinders now...column H should be the first blank
 - Label H1 Cylinder 1
 - Name H3 to be cyl1ht and enter 1
 - Label H4 Volume
 - Label I4 Surface Area
 - Label J1 Cylinder 2
 - Name J3 to be cyl2ht and enter 2
 - Label J4 Volume
 - Label K4 Surface Area
 - Select the whole spreadsheet and autofit the columns again.
- Determine Volume
 - Review the formula $\pi r^2 h$
 - In H6 (yes, down one) Enter $=\text{pi}()*G6^2*\text{cyl1ht}$ and discuss what Pi() represents, G6 represents, ^ represents, and check the substitution for calculation accuracy.
 - Fill down to H27 and Edit/Fill/Up to H5. Check a couple for accuracy. Look at the formulas in that column to see what they represent. What happens when the diameter is 0?
 - Change the height to 2 and check the results for accuracy. Again discuss substitution. Note the volume is not steadily increasing for an increasing radius.
- Determine Surface Area
 - Review the formula $2\pi r^2 + 2\pi rh$

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- Change the height back to 1
- In I5 (again, down one) enter $=2*\pi()*G5^2+2*\pi()*G5*cyl1ht$
- Fill down through I27
- Check the result in I6 to be accurate (12.57).
- As an extension, discuss the surface area if the radius is 0.
- Change the height to 2 and discuss the SA does not double.
- Create the same representation for cylinder 2
 - Enter the appropriate formula in J5 and K5 and check the results match those for cylinder 1.
 - Have cyl1 have a ht of 1 and cyl2 a ht of 2. Discuss volume relationship. Try other values to see when volume doubling occurs.
 - Try ht of 10 and note pattern ($\pi=3.1415926535\dots$) of numbers with diameter if 20.
 - Try heights of 10 and 40 and note volumes where diameter is 20 and 10.
- Compare volume & SA between ht/dia 10/10 vs. 5/20 – notice doubling of both, but look for another example. (10/9 vs. 5/18 is not doubled in one direction and 10/11 vs. 5/22 is off in the other direction.
- Compare and discuss surface area between cube with sides of 10 and cylinder of height 10 and diameter of 10.
- Look for any other patterns that may come to mind or you have time for.
- Save if appropriate
- Before printing to see each student’s results, have them:
 - leave rp1 as 4x6
 - leave rp2 as 3x8
 - leave cyl1 as 10
 - leave cyl2 as 5

Practice Activities:

none

Challenge & Closure:

Ask what was learned about how to work Excel.
 Rephrase/ask the Ticket questions to reinforce desired conclusions.

Homework Assignment:

Ticket-out-the-door
 Assessment:

- In addition to their printed spreadsheet, the following questions should also be answered and scored:
- What was one of the variable names we established in this activity?
 - What was one of the formulas put into the spreadsheet?
 - How is a value squared represented in an excel formula?
 - Does Excel know about order of operations or PEMDAS?
 - How was Excel showing the use of substitution?
 - Is Excel rounding off or chopping off digits to the right of the decimal?
 - When one rectangular prism side is doubled, the volume is _____.
 - Is a rectangular prism of 2x3x4 the same volume as a rectangular prism of 3x2x4?
 - When a cylinder height is doubled, the volume is _____.
 - When a cylinder radius is doubled, the volume is _____.
 - When comparing two rectangular prisms of the same volume, is there less surface area if it is long/narrow or if it more like a cube?

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- When one rectangular prism side is doubled, how does the surface area change?
- When a cylinder height is doubled, how does the surface area change?
- When a cylinder radius doubles, how does the surface area change?
- Compare a cube with sides of 10 to a cylinder of height 10 and diameter 10.

Rubric:

Looking at their spreadsheet printout, 1 point each for a total up to 7

- width/diameter/radius columns established
- printed with settings requested
- rp1 results correct
- rp2 results correct
- cyl1 results correct
- cyl2 rresults correct
- neat organized

Looking at the questions, there are 15 for a point apiece.

Total score could be 22.